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Application No. 10/782,731
After Final Office Action of April 8, 2008

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Docket No.: 60893(70840)

AMENDMENTS TO THE CLAIMS

Amendments to the Claims

This listing of claims will replace all prior versions, and listing, of claims in the application.

Listing of Claims

1 (Previously presented). A semiconductor apparatus comprising:

a light input/output portion provided in an upper portion of a semiconductor substrate, the light input/output portion having an opening region for light associated to the light input/output portion to pass through, the opening region having a central axis and being bounded by a light shielding layer;

a transparent film covering and contacting the opening region, said transparent layer having an upper surface opposite the opening region, wherein said upper surface has a concave region formed therein above the opening region; and

an interlayer lens provided on the concave region formed in the upper surface of the transparent film, the interlayer lens positioned such that an optical axis of the interlayer lens is aligned with the central axis of the opening region, so that the optical axis of the interlayer lens and the central axis of the opening region are parallel and matched,

wherein the light shielding layer is asymmetric with respect to the central axis of the opening region, as viewed from a cross-section of the semiconductor apparatus, said central axis being perpendicular to the surface of the semiconductor substrate.

2 (Previously presented). A semiconductor apparatus according to claim 1, wherein the light input/output portion includes a light receiving portion for receiving light.

3 (Previously presented). A semiconductor apparatus according to claim 1, wherein the transparent film is provided with step portions so as to provide said upper region, and the concaved portion covers the opening region.

4 (Cancelled).

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5 (Original). A semiconductor apparatus according to claim 1, wherein a refractive index of the transparent film is lower than a refractive index of the interlayer lens.

6 (Original). A semiconductor apparatus according to claim 5, wherein the transparent film includes a silicon oxide film including at least one of phosphorous (P) and boron (B).

7 (Original). A semiconductor apparatus according to claim 5, wherein the transparent film includes an organic high polymer film.

8 (Original). A semiconductor apparatus according to claim 1, wherein the transparent film is formed by patterning using selective etching.

9 (Original). A semiconductor apparatus according to claim 8, wherein the transparent film is formed by a thermal process after the patterning.

10 (Previously presented). A semiconductor apparatus according to claim 1, further comprising:
a transfer channel provided so as to have a predetermined space from the light input/output portion;
a first insulating film provided on the semiconductor substrate, the light input/output portion and the transfer channel;
a transfer electrode provided so as to oppose the transfer channel via the insulating film; and
a second insulating film provided with an opening for exposing the opening region of the light input/output portion and in which step portions are produced by covering the transfer electrode.

11 (Cancelled).

12 (Previously presented). A method for fabricating a semiconductor apparatus comprising:

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forming a light input/output portion having an opening region for passing through associated light in an upper portion of a semiconductor substrate, the opening region having a central axis;

forming a light shield layer with an opening for exposing the opening region of the light input/output portion;

forming a transparent film so as to cover and contact the opening region, said transparent layer having an upper surface opposite the opening region;

forming a concave region in the upper surface of the transparent film; and

forming an interlayer lens provided on the concave region formed in the upper surface of the transparent film, the interlayer lens being formed such that an optical axis of the interlayer lens is aligned with the central axis of the opening region, so that the optical axis of the interlayer lens and the central axis of the opening region are parallel and matched,

wherein the light shielding layer is asymmetric with respect to the central axis of the opening region, as viewed from a cross-section of the semiconductor apparatus, said central axis being perpendicular to the surface of the semiconductor substrate.

13 (Original). A method for fabricating a semiconductor apparatus according to claim 12, wherein forming the light input/output portion includes forming a light receiving portion for receiving light as the light input/output portion.

14 (Cancelled).

15 (Cancelled).

16 (Withdrawn). A method for fabricating a semiconductor apparatus according to claim 12, wherein forming the transparent film includes selectively etching and patterning the transparent film.

17 (Withdrawn). A method for fabricating a semiconductor apparatus according to claim 16, wherein forming the transparent film includes performing a thermal process after patterning.

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18 (Withdrawn). A method for fabricating a semiconductor apparatus according to claim 16, wherein forming the transparent film includes flattening a surface of the transparent film before the step of patterning.

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